

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1. (Currently amended) An optical module arranged in an optical transmission path, comprising:

an optical amplifying unit configured with a semiconductor, wherein the optical amplifying unit amplifies in high gain light input from the optical transmission path; and

an optical element configured with a semiconductor, wherein the optical element includes an optical modulator, disposed in series with ~~and behind~~ the optical amplifying unit and propagates the light amplified by the optical amplifying unit to the optical transmission path, and is operative to produce gain sufficiently high that insertion loss of the optical module is completely compensated, ~~wherein the optical modulator is a directional coupler modulator~~

the optical module further comprises a dc current controller configured to control the optical amplifying unit to inject a dc current in a reverse direction or a dc current equal or less than a predetermined value in a forward direction and to control an optical attenuation.

2-3. Canceled.

4. (Previously presented) An optical module arranged in an optical transmission path, comprising:

an optical amplifying unit configured with a semiconductor, and disposed in series with and behind the optical amplifying unit, wherein the optical amplifying unit amplifies in high gain light input from the optical transmission path; and

an optical element configured with a semiconductor, wherein the optical element includes an optical modulator, and propagates the light amplified by the optical amplifying unit to the optical transmission path, and is operative to produce gain sufficiently high that insertion loss of the optical module is completely compensated, wherein the optical element comprises:

a first optical waveguide through which light from the optical amplifying unit propagates;

a second optical waveguide through which light propagates, wherein the second optical waveguide optically crosses the first optical waveguide to form a crossing portion;

a first lead electrode arranged along the first optical waveguide and the second optical waveguide;

a pair of first control electrodes arranged along the first optical waveguide so as to face each other, with the crossing portion therebetween, to which a control voltage controlling a crossing state is applied via the first lead electrode;

a second lead electrode arranged so as to face the first lead electrode; and

a pair of second control electrodes arranged along the second optical waveguide so as to face each other, with the crossing portion therebetween, to which the control voltage is applied via the second lead electrode.

5. (Original) The optical module according to claim 4, wherein the first lead electrode and the second lead electrode are arranged so as to face each other, with the first optical waveguide and the second optical waveguide arranged therebetween.

6. (Original) The optical module according to claim 5, wherein the first lead electrode and the second lead electrode are arranged substantially parallel with each other.

7. (Original) The optical module according to claim 4, wherein the first optical waveguide and the second optical waveguide are arranged in a physically solid crossing state.

8-11. Canceled.

12. (Original) The optical module according to claim 4, wherein each of the first control electrodes and the second control electrodes have a control electrode piece divided into a plurality of parts in the longitudinal direction.

13. (Original) The optical module according to claim 12, wherein each of the first optical waveguide and the second optical waveguide has a PIN structure in which an I-core layer is put between a P-cladding layer and an N-cladding layer, in regions other than the regions immediately below the control electrode pieces, which are adjacent to each other in the longitudinal direction, wherein corresponding control electrode piece is deposited on the P-layer,

the optical waveguide immediately below a region between the control electrode pieces adjacent to each other in the longitudinal direction has a structure in which the P-layer is removed from the PIN structure, and

the N-layer in the PIN structure is a common layer to the first optical waveguide and the second optical waveguide.

14. (Original) The optical module according to claim 4, wherein each of the first optical waveguide and the second optical waveguide has the PIN structure of a three-layer type or an I-layer buried type, wherein in the case of the three-layer type, the first control electrode and the second control electrode are deposited respectively on the P-layer of the first optical waveguide and the second optical waveguide, and in the case of the I-layer buried type, the first control electrode and the second control electrode are deposited respectively on the I-layer of the first optical waveguide and the second optical waveguide, N-layer of the first optical waveguide and the second optical waveguide are deposited, and the first optical waveguide and the second optical waveguide have a common N+ layer to which a DC bias voltage is applied.

15-17. Canceled.

18. (Previously presented) The optical module according to claim 1, wherein the optical element comprises:

a first optical waveguide through which light from the optical amplifying unit propagates;

a second optical waveguide through which light propagates, wherein the second optical waveguide optically crosses the first optical waveguide to form a crossing portion;

a first lead electrode arranged along the first optical waveguide and the second optical waveguide;

a pair of first control electrodes arranged along the first optical waveguide so as to face each other, with the crossing portion therebetween, to which a control voltage controlling a crossing state is applied via the first lead electrode;

a second lead electrode arranged so as to face the first lead electrode; and

a pair of second control electrodes arranged along the second optical waveguide so as to face each other, with the crossing portion therebetween, to which the control voltage is applied via the second lead electrode.

19. (Previously presented) The optical module according to claim 18, wherein the first lead electrode and the second lead electrode are arranged so as to face each other, with the first optical waveguide and the second optical waveguide arranged therebetween.

20. (Previously presented) The optical module according to claim 19, wherein the first lead electrode and the second lead electrode are arranged substantially parallel with each other.

21. (Previously presented) The optical module according to claim 18, wherein the first optical waveguide and the second optical waveguide are arranged in a physically solid crossing state.

22. (Previously presented) The optical module according to claim 18, wherein each of the first control electrodes and the second control electrodes have a control electrode piece divided into a plurality of parts in the longitudinal direction.

23. (Previously presented) The optical module according to claim 22, wherein each of the first optical waveguide and the second optical waveguide has a PIN structure in which an I-core layer is put between a P-cladding layer and an N-cladding layer, in regions other than the regions immediately below the control electrode pieces, which are adjacent to each

other in the longitudinal direction, wherein corresponding control electrode piece is deposited on the P-layer,

the optical waveguide immediately below a region between the control electrode pieces adjacent to each other in the longitudinal direction has a structure in which the P-layer is removed from the PIN structure, and

the N-layer in the PIN structure is a common layer to the first optical waveguide and the second optical waveguide.

24. (Previously presented) The optical module according to claim 18, wherein each of the first optical waveguide and the second optical waveguide has the PIN structure of a three-layer type or an I-layer buried type, wherein in the case of the three-layer type, the first control electrode and the second control electrode are deposited respectively on the P-layer of the first optical waveguide and the second optical waveguide, and in the case of the I-layer buried type, the first control electrode and the second control electrode are deposited respectively on the I-layer of the first optical waveguide and the second optical waveguide, N-layer of the first optical waveguide and the second optical waveguide are deposited, and the first optical waveguide and the second optical waveguide have a common N+ layer to which a DC bias voltage is applied.

25. (Previously presented) The optical module according to claim 4, wherein the crossing portion constitutes a 2×2 multi-mode interference coupler.

26 (Previously presented) The optical module according to claim 4, wherein the crossing portion constitutes an X crossing waveguide.

27. (Previously presented) The optical module according to claim 4, wherein the first optical waveguide and the second optical waveguide are arranged in the crossing portion, substantially in parallel with and close to each other.

28. (Previously presented) The optical module according to claim 27, wherein a gap between the first optical waveguide and the second optical waveguide in the

crossing portion is narrower than a gap between the first optical waveguide and the second optical waveguide in portions other than the crossing portion.

29. (Previously presented) The optical module according to claim 4, further comprising a directional-coupler-type optical attenuator having

a third optical waveguide formed by extending at least one of the first optical waveguide and the second optical waveguide;

a fourth optical waveguide arranged in parallel with and close to the third optical waveguide, so that optical coupling occurs between the third optical waveguide and the fourth optical waveguide; and

a third control electrode arranged along the fourth optical waveguide, to change the refractive index of the core layer by applying an electric field to the core layer in the fourth optical waveguide.